TCM Teacher Created Materials

Lessons and Activities

50 Strategies for Teaching STEAM Skills Grades K–12

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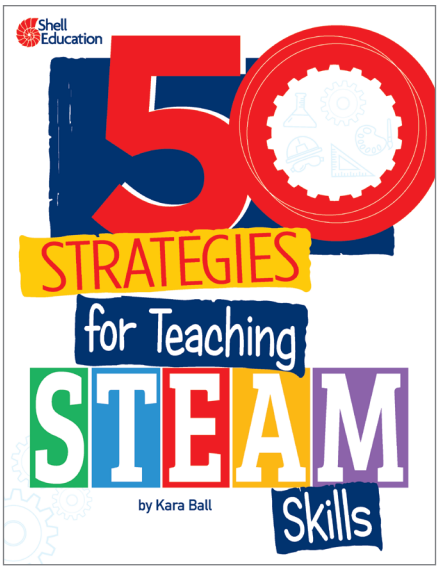

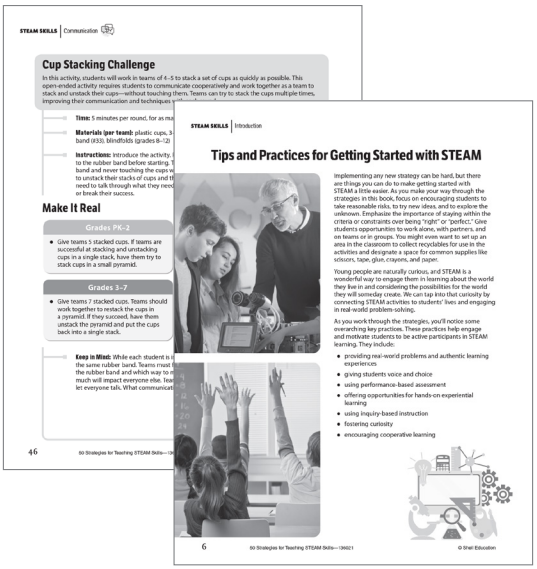

Shell Education

50 Strategies for Teaching STEAM Skills

Kara Ball

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Welcome

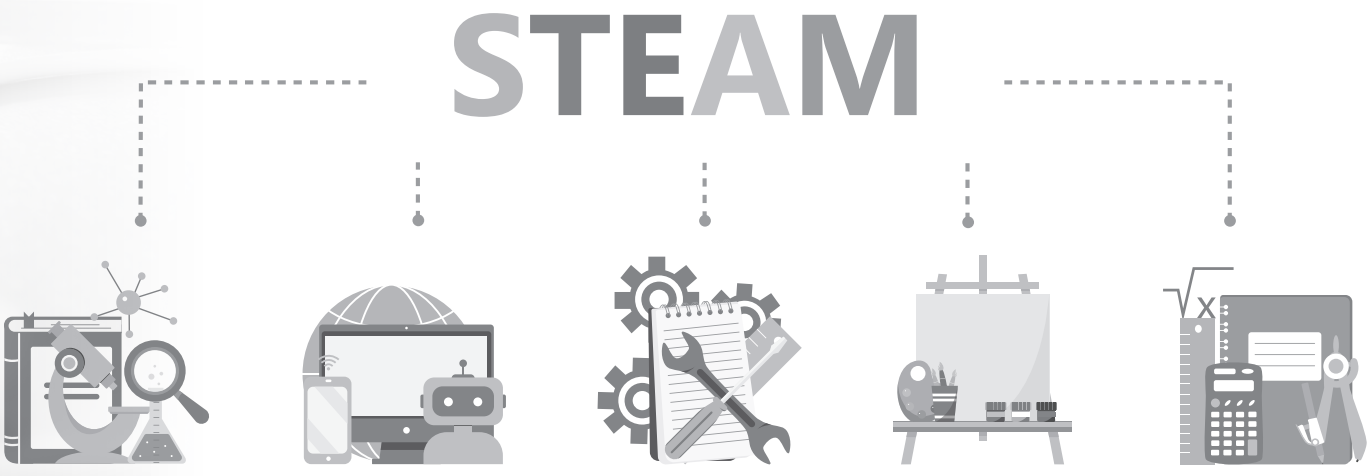
STEAM (science, technology, engineering, arts, and mathematics) education is not new, but its importance continues to grow. STEAM education provides students with the skills necessary to succeed today and excel tomorrow. Although STEAM has been gaining popularity for years, guidance for educators on how to get started with it is still sparse. This book provides fifty standalone strategies that teachers can do with students in grades PK–12. The strategies are bundled into five sections that each focus on an essential STEAM skill: creativity, communication, collaboration, critical thinking, and, most important, failing. Each section includes ten strategies that give students an opportunity to build the skill.

This book is born from the work of countless educators who recognized the importance of providing their students with STEAM experiences and began creating activities to do so. Over the years, I have worked with other STEAM educators to identify and create activities that could be done in a single class period or extended over multiple days. I led professional learning sessions with hundreds of educators, building a community with them and collaborating around ideas that would become the foundation for the strategies in this book.

This collection of strategies is not exhaustive. Every day, teachers are sharing creative and innovative ideas for how to engage students in STEAM. It is, however, a collection of activities I have used in my work as a STEAM teacher, curriculum writer, and coordinator to build essential skills for STEAM learning.

The resources and information about STEAM education are ever-growing and evolving. Be a part of this conversation. Make these strategies your own and inspire your students to be the inventors and innovators of today, tomorrow, and the future.

—Kara Ball



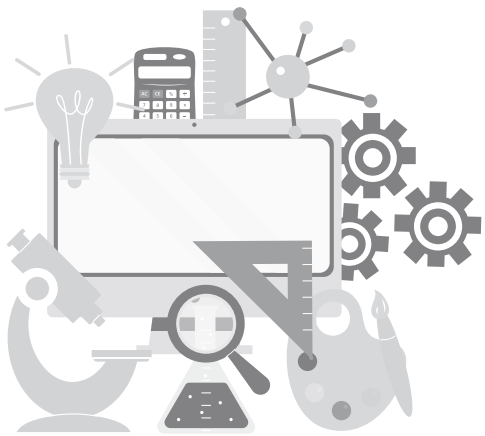
Tips and Practices for Getting Started with STEAM

Implementing any new strategy can be hard, but there are things you can do to make getting started with STEAM a little easier. As you make your way through the strategies in this book, focus on encouraging students to take reasonable risks, to try new ideas, and to explore the unknown. Emphasize the importance of staying within the criteria or constraints over being "right" or "perfect." Give students opportunities to work alone, with partners, and on teams or in groups. You might even want to set up an area in the classroom to collect recyclables for use in the activities and designate a space for common supplies like scissors, tape, glue, crayons, and paper.

Young people are naturally curious, and STEAM is a wonderful way to engage them in learning about the world they live in and considering the possibilities for the world they will someday create. We can tap into that curiosity by connecting STEAM activities to students' lives and engaging in real-world problem-solving.

As you work through the strategies, you'll notice some overarching key practices. These practices help engage and motivate students to be active participants in STEAM learning. They include:

- providing real-world problems and authentic learning experiences
- giving students voice and choice
- using performance-based assessment
- offering opportunities for hands-on experiential learning
- using inquiry-based instruction
- fostering curiosity
- encouraging cooperative learning



You can incorporate these strategies into any part of your day. When I was in the classroom, I found the end of the day to be a wonderful time for STEAM activities. This allowed me to use STEAM as an incentive for the day and as motivation for students to work on subjects they might otherwise avoid. If there was an activity that needed to sit overnight, it was easy to leave at the end of the day without disrupting other instructional blocks. If you aren't able to set aside a dedicated time block for STEAM in your schedule, you might create a STEAM station or center in your classroom instead.

Also consider these questions when planning STEAM activities:

- Where will I store supplies and materials?
- What materials can students have access to without direct supervision?
- How will students collect and gather materials for activities?
- What grouping strategies will I use for group activities?
- Where can the students work?
- How will students document their work?
- Is there an area in the school building to display student creations?
- During activities that require additional adult support, how will I find volunteers?

How to Use This Resource

The strategies in this book are organized into five sections that each focus on a specific STEAM skill: failing, creativity, communication, collaboration, and critical thinking. Each section includes ten strategies to help students build the skill. You can choose to work through a section by having your students complete each strategy. Or you can choose a strategy at random and give it a whirl. However you make your way through the individual strategies, be sure to review materials lists ahead of time. Most activities use common items found in schools and classrooms, but there are some where you'll likely need to gather additional materials.

This introductory text provides a brief overview of the strategy and how it teaches the STEAM skill. You may choose to read this section aloud to students when introducing the strategy.

Time needs are suggested. Shortening the time for a strategy often increases the challenge for students.

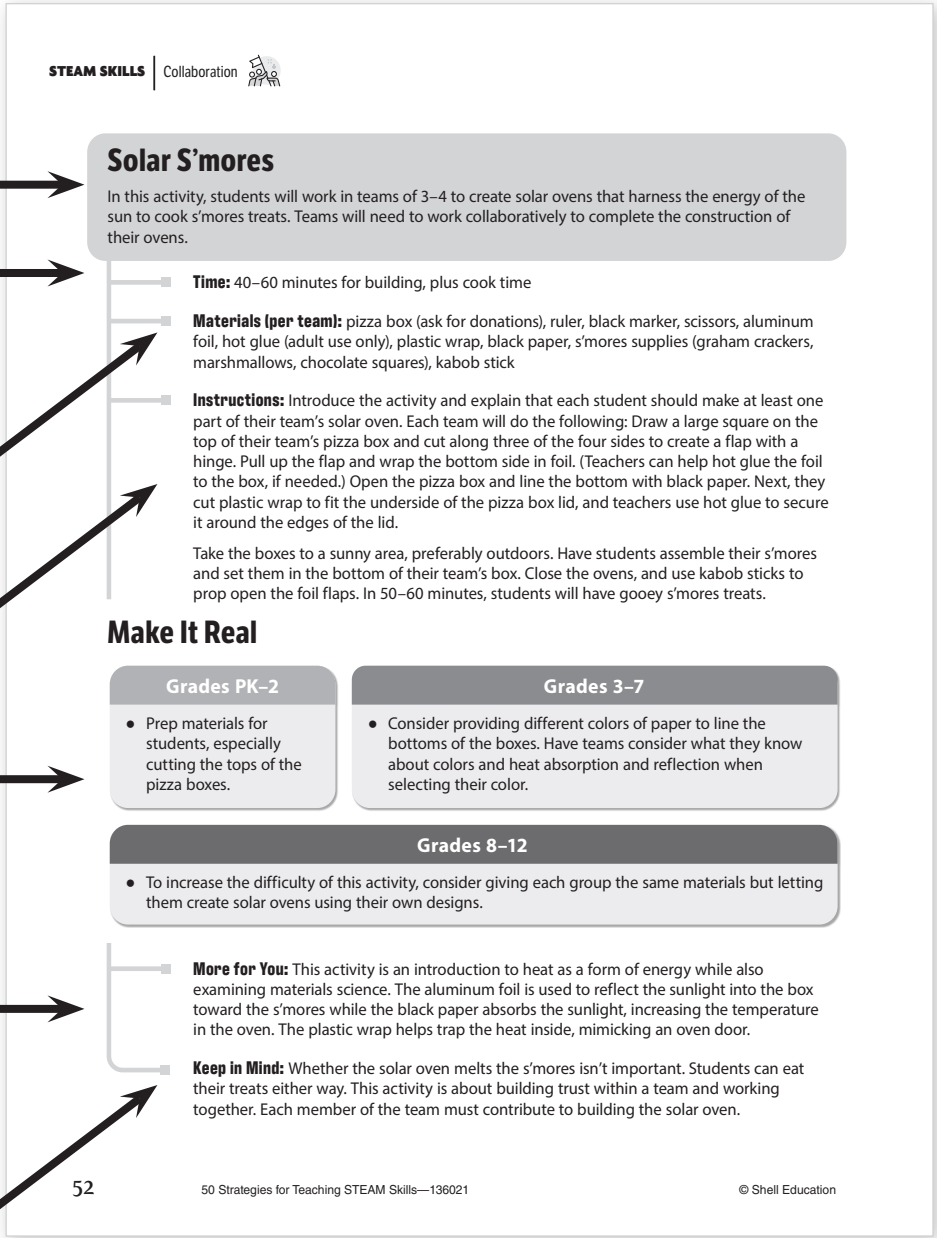
These are the materials you'll need to complete the strategy.

Instructions for leading the strategy are provided here.

Differentiation ideas are provided. Most strategies include differentiation ideas for three grade ranges. Be sure to check out all the options!

Some strategies share additional information and resources to support your teaching.

These notes are key things to think about when using the strategy.



STEAM SKILLS | Collaboration

Solar S'mores

In this activity, students will work in teams of 3–4 to create solar ovens that harness the energy of the sun to cook s'mores treats. Teams will need to work collaboratively to complete the construction of their ovens.

Time: 40–60 minutes for building, plus cook time

Materials (per team): pizza box (ask for donations), ruler, black marker, scissors, aluminum foil, hot glue (adult use only), plastic wrap, black paper, s'mores supplies (graham crackers, marshmallows, chocolate squares), kabob stick

Instructions: Introduce the activity and explain that each student should make at least one part of their team's solar oven. Each team will do the following: Draw a large square on the top of their team's pizza box and cut along three of the four sides to create a flap with a hinge. Pull up the flap and wrap the bottom side in foil. (Teachers can help hot glue the foil to the box, if needed.) Open the pizza box and line the bottom with black paper. Next, they cut plastic wrap to fit the underside of the pizza box lid, and teachers use hot glue to secure it around the edges of the lid.

Take the boxes to a sunny area, preferably outdoors. Have students assemble their s'mores and set them in the bottom of their team's box. Close the ovens, and use kabob sticks to prop open the foil flaps. In 50–60 minutes, students will have gooey s'mores treats.

Make It Real

Grades PK–2

- Prep materials for students, especially cutting the tops of the pizza boxes.

Grades 3–7

- Consider providing different colors of paper to line the bottoms of the boxes. Have teams consider what they know about colors and heat absorption and reflection when selecting their color.

Grades 8–12

- To increase the difficulty of this activity, consider giving each group the same materials but letting them create solar ovens using their own designs.

More for You: This activity is an introduction to heat as a form of energy while also examining materials science. The aluminum foil is used to reflect the sunlight into the box toward the s'mores while the black paper absorbs the sunlight, increasing the temperature in the oven. The plastic wrap helps trap the heat inside, mimicking an oven door.

Keep in Mind: Whether the solar oven melts the s'mores isn't important. Students can eat their treats either way. This activity is about building trust within a team and working together. Each member of the team must contribute to building the solar oven.

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Skill 1: Failing Your Way to Success

Failure is often considered to be a bad thing—the opposite of success and certainly best avoided. However, most people experience failure far more often than they do success, and we usually learn a lot from our failures.

When I teach students about failure, I like to describe it as "not meeting an objective" or "not having the desired outcome." But this doesn't necessarily mean that what occurs is bad. Sometimes, and maybe even most times, failure is an important teacher—showing us where we went wrong and what we might do differently when we try again.

The Strategies

The Role of the Teacher

Students are going to experience a lot of failure when trying to complete the STEAM activities in this and subsequent skills. That's good! Let failure happen, and help students accept and learn from it. We don't want students to fear failure. Rather, we want them to view it as an opportunity to learn from mistakes and improve. This ability to view failure as a step toward success is directly connected to an ability to persist when challenged.

So when failures happen, remind students that it's okay to make mistakes. If a student is getting frustrated, support them by asking what worked, what didn't work, and what they could try differently. You can also encourage them to seek help from peers and get a second opinion. Resiliency in failure is an important skill in the classroom and beyond.

Failing as a STEAM Skill

No one—not scientists, artists, programmers, or teachers—gets everything right on the first try. Learning to cope with (and even celebrate) failing is an important skill and can help students understand why and how to make the most of it when things go wrong.

The strategies in this chapter are designed so that students experience failure. As you complete them, keep an eye out for opportunities to celebrate, learn from, and persevere through mistakes. Here are some helpful things you can do in these moments.

Share examples of famous failures and mistakes. For example, in 1968, a chemist named Spencer Silver was trying to create a superstrong adhesive for the aerospace industry, but his experiments resulted in a very weak glue. Six years later, another scientist who worked with Silver got annoyed at bookmarks that kept falling out of books and used some of Silver's glue on small sheets of paper. Since then, the Post-it Note has become one of the most popular office supplies in the world. Sharing this and other famous failures can help students begin to see failure as a stepping stone toward success. Can students think of any times in their lives when something good came from a mess-up?

Model how to cope with failure. You might tell a story of a time you felt disappointed when something didn't go to plan or use an example from a popular movie or book. Be sure to share how you or the character kept trying in these situations. It's also good to talk about the real cost of the failure ("It wasn't as bad as it felt because . . .") and model how you reframe it into a first step ("It helped me think about . . .").

Share the FAIL acronym. How can students reframe when they FAIL? By recognizing failures as a **F**irst **A**ttempt **I**n **L**earning. Teach students this acronym and refer to it whenever they struggle, helping them internalize its message. ("It didn't work? Great! What did you learn from it? What can we try next?") Being upbeat and celebrating failure as a first step in learning can help students see mistakes in a more positive light.

Leaning Tower of Pasta

Working together in teams of 3–4, students will build the tallest possible spaghetti-noodle tower that can hold the weight of one marshmallow. Spaghetti noodles are not a strong material and are subject to breaking. This can be frustrating for students, but it's important for them to persist in building their towers despite the challenges that come from working with this unconventional material.

Time: 10–25 minutes for building, plus measuring time

Materials (per team): dry spaghetti noodles, masking tape, string, ruler, scissors, marshmallow

Instructions: Introduce the activity. Avoid showing examples of towers since students may mimic the designs. Give teams time to build their towers. When time is up, allow teams to view each other's designs. Measure each team's tower to determine which is the tallest. Talk about the failures teams experienced in building their towers and what they did when failures happened.

Make It Real

Grades PK–2

- Give younger students only 10–12 noodles at a time to encourage them to be careful with the materials and reduce waste. They can ask for more noodles if needed.

Grades 3–7

- Provide students with the option to measure the height of their towers themselves.

Grades 8–12

- After measuring all teams' towers, determine the average, mean, and median heights.
- If a tie for the tallest tower occurs, conduct a tiebreaker using extra marshmallows. The winning tower is the one that holds the most marshmallow weight.

More for You: Consider conducting this activity as a schoolwide challenge and sharing the results on a school bulletin board.

Keep in Mind: Many students, especially as they get older, worry about making mistakes or failing when presented with a challenge. They may be reluctant to try creative ideas and hesitant to speak up within their teams. Dedicate some time at the end of this activity to discussing what successful teams did, emphasizing that worrying about failure decreases the odds of experiencing success.

Cup Stacking Challenge

In this activity, students will work in teams of 4–5 to stack a set of cups as quickly as possible. This open-ended activity requires students to communicate cooperatively and work together as a team to stack and unstack their cups—without touching them. Teams can try to stack the cups multiple times, improving their communication and techniques with each round.

Time: 5 minutes per round, for as many rounds as you'd like

Materials (per team): plastic cups, 3-foot lengths of string or yarn (1 per student), rubber band (#33), blindfolds (grades 8–12)

Instructions: Introduce the activity. For younger students, you may want to tie their strings to the rubber band before starting. Touching only the strings tied to their team's rubber band and never touching the cups with their hands, students need to use the rubber bands to unstack their stacks of cups and then restack them. (See figure 3.1.) Emphasize that teams need to talk through what they need to do to be successful. Good communication will make or break their success.

Make It Real

Grades PK–2

- Give teams 5 stacked cups. If teams are successful at stacking and unstacking cups in a single stack, have them try to stack cups in a small pyramid.

Grades 3–7

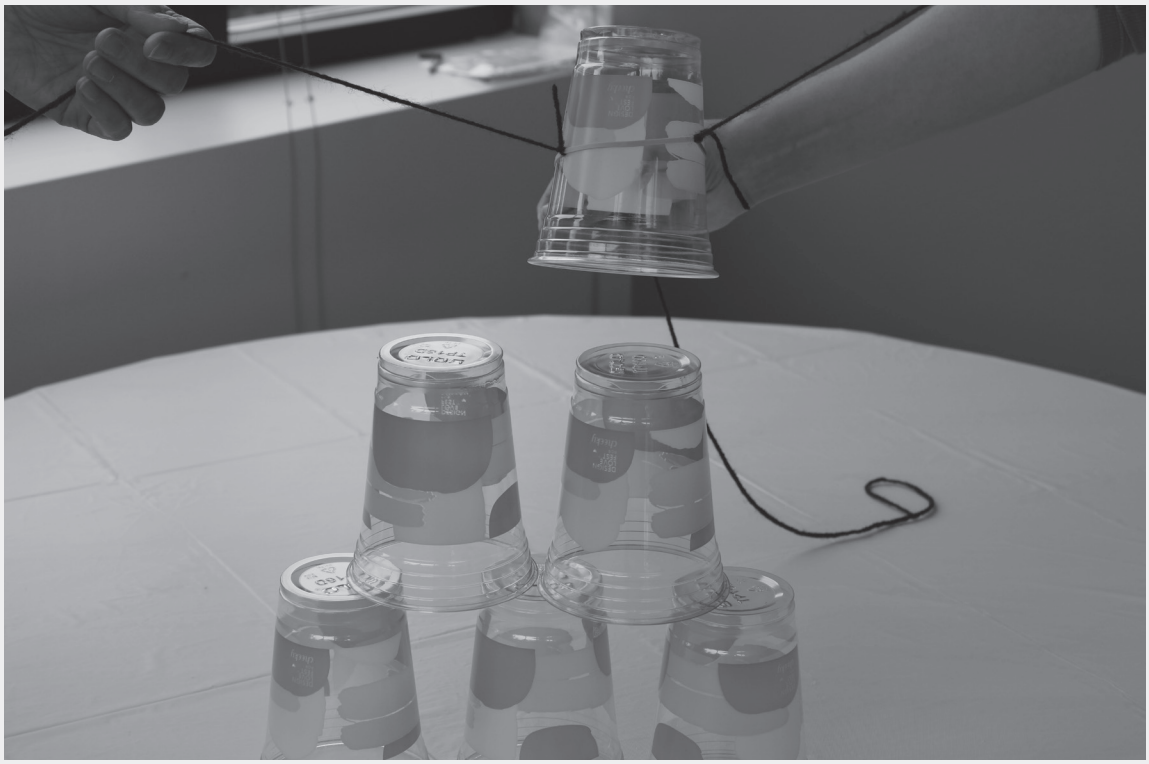
- Give teams 7 stacked cups. Teams should work together to restack the cups in a pyramid. If they succeed, have them unstack the pyramid and put the cups back into a single stack.

Grades 8–12

- Give teams 12 stacked cups. Teams should work together to restack the cups in a pyramid or whatever tall shape they can create. If they succeed, have them unstack the pyramid and put the cups back into the single stack.
- Have teams pick three people to be the string holders. The remaining team members will be the coaches. Coaches blindfold the string holders and verbally coach them through stacking the cups.

Keep in Mind: While each student is in control of their string, the strings are all connected to the same rubber band. Teams must figure out how much or how little they should pull on the rubber band and which way to move to move their cups around. One person pulling too much will impact everyone else. Teams may want to designate one person as the coach or let everyone talk. What communication strategy works best for each team will vary.

figure 3.1: cup stacking



Circle Spinners

In this activity, each student will create an old-fashioned spinning toy using geometry, physics, and art. Students will need to think critically about their geometric art and how their design transforms when in motion.

Time: 30 minutes

Materials (per student): paper plate, cup (grades PK–2) or compass (grades 3–7), pencil, ruler, scissors, markers, penny; **additional materials for string spinner extension:** cardboard, glue, paper, 16-inch piece of string, thumbtack

Instructions: Introduce the activity and remind students that their pennies should not go in their mouths. Each student will do the following: Draw a circle by tracing a paper cup or using a compass on their paper plate. Use a ruler to divide their circle into fourths or sixths. Then color the circle, creating a new geometric design in each section, and cut it out. Cut a slit that is slightly smaller than the penny in the center of the circle. Push their penny into the slit. (See figure 5.2.) Holding the penny between their fingers, spin their spinner on a hard surface. It may take a few tries to get the spinner to spin. As their spinners spin, invite students to view them and think critically about how the designs they created look when spun.

String Spinner Extension: Each student will do the following: Create and cut out two circles from paper. Then create a third circle on a piece of cardboard and cut it out. Glue one paper circle to each side of the cardboard circle and decorate each side with a geometric design. Using a thumbtack, punch two holes through the center of the circle and thread one end of a string through each hole to create a loop. (See figure 5.3.) Tie the two ends together. Wind up the spinner by holding the string loops in each hand, and watch their designs spin. Students will need to think critically about how to get their circles to spin and keep on spinning.

Make It Real

Grades PK–2

- Model how to draw different types of lines (zigzag, squiggle, diagonal, etc.). Encourage students to think critically about how they could use different lines and shapes in their designs.

Grades 3–7

- If time permits, invite students to add to their geometric designs to change how their spinners look when spun.

Grades 8–12

- Students create string spinners following the String Spinner Extension instructions.

Keep in Mind: Some students may not be able to spin the penny or string spinner on the first try. Both of these spinning activities will require students to use trial and error to get their circles to spin. If students become frustrated, ask them to think about what isn't working and what changes they could make. Problem-solving is a critical-thinking skill that students need time to practice, especially when frustrated.

figure 5.2: penny spinner

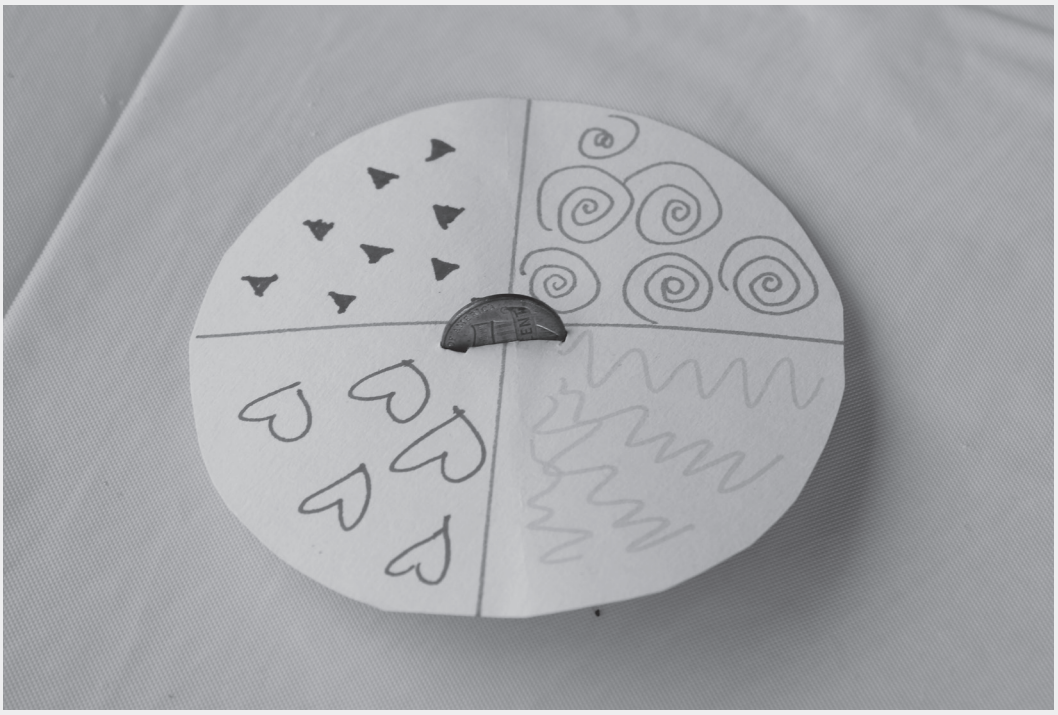
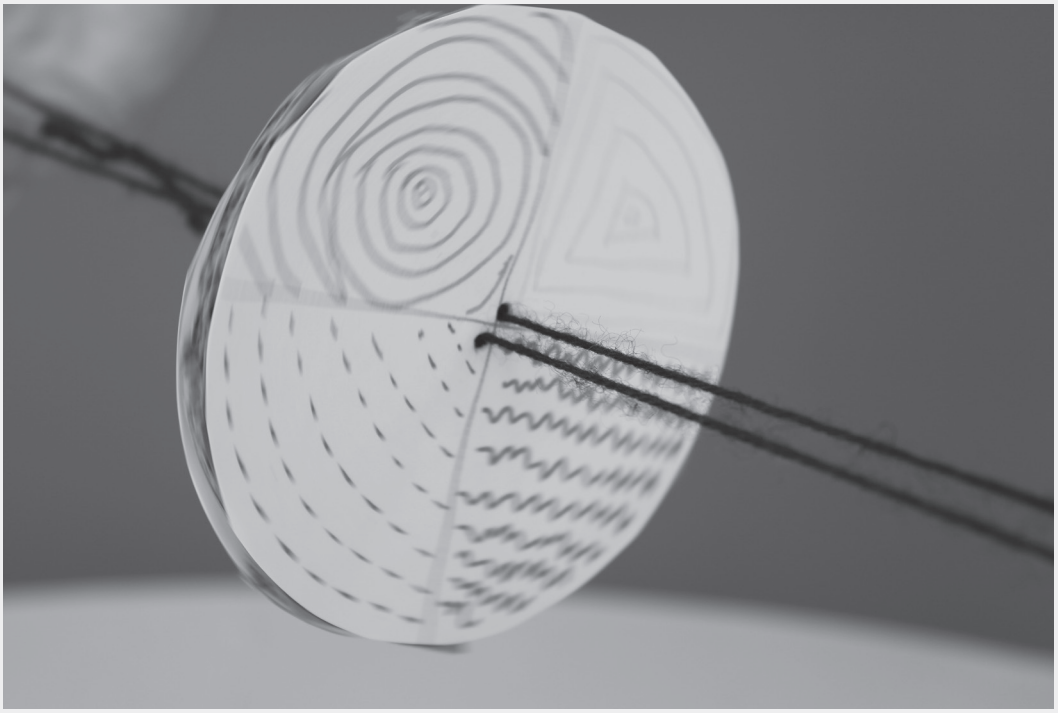
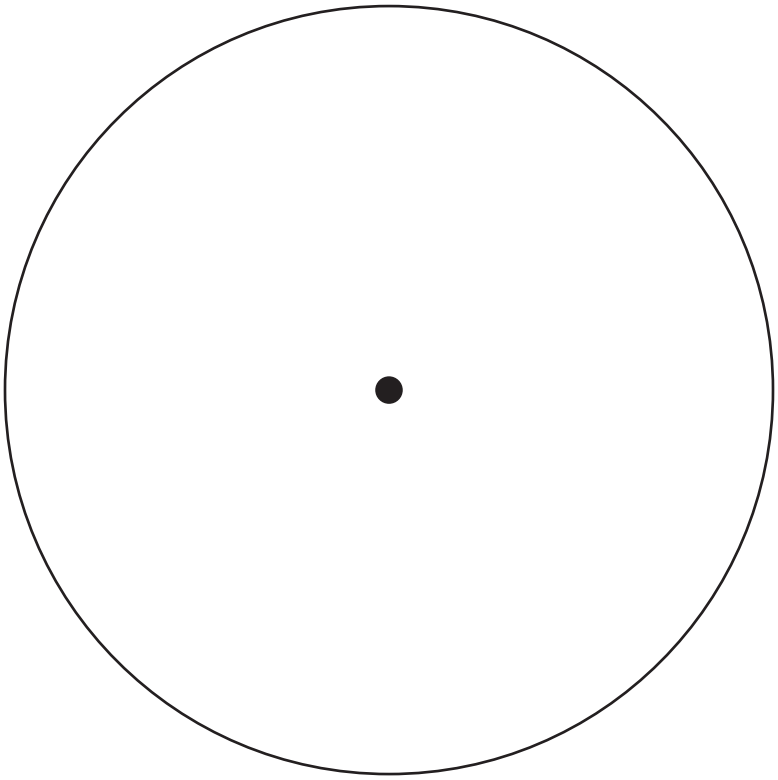


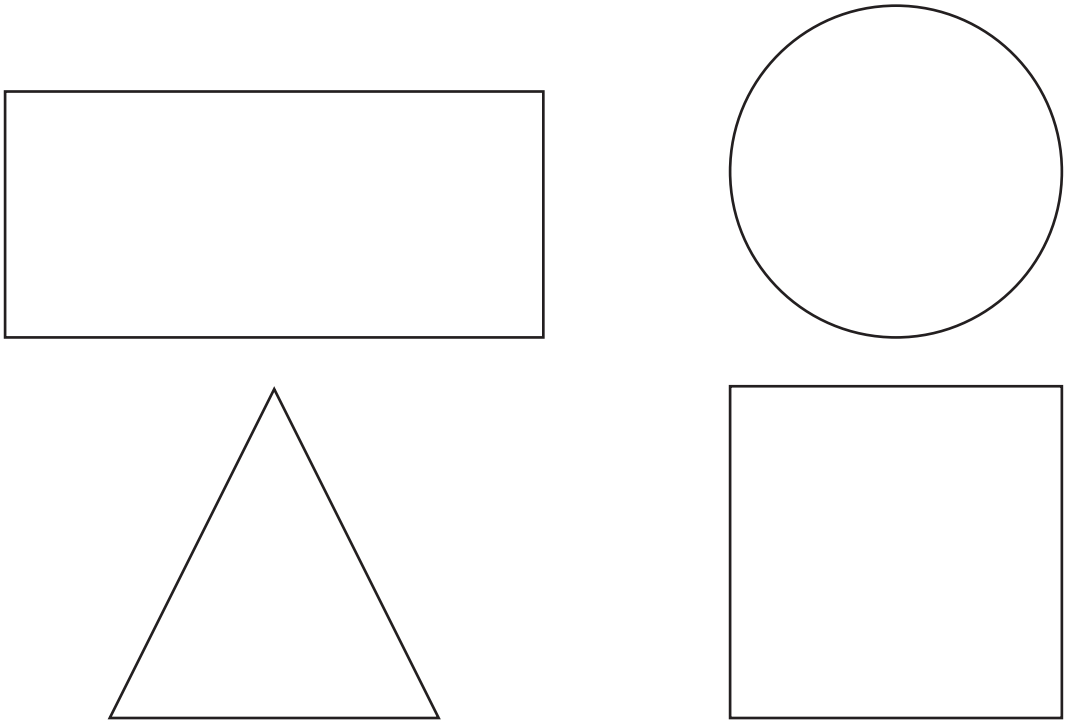
figure 5.3: string spinner

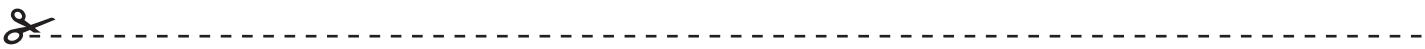


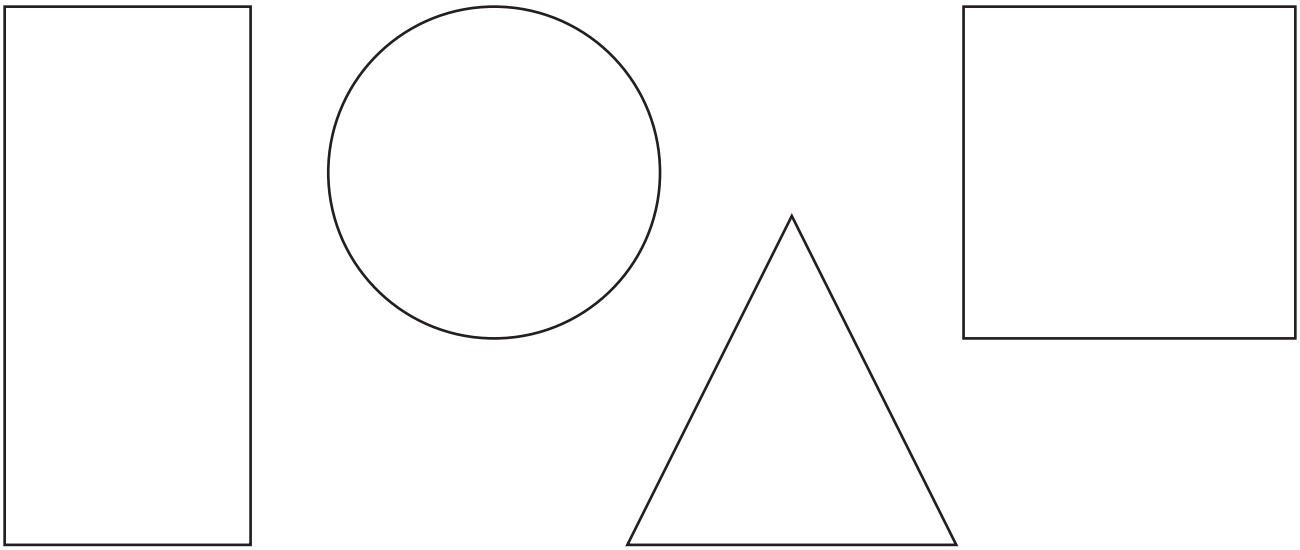
Circle Template



Sample Drawing A







Paper Airplane Folding Instructions

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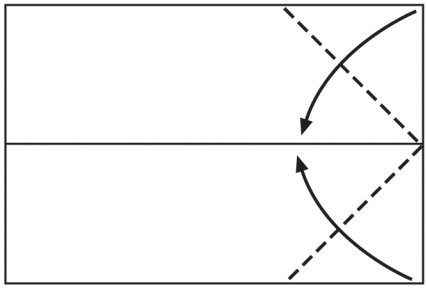

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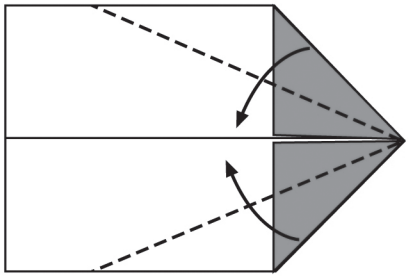

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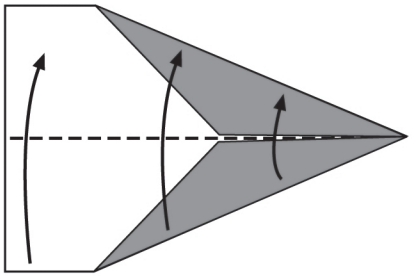

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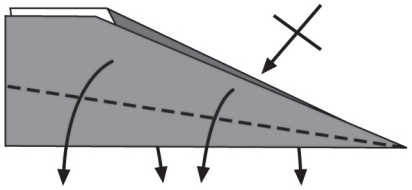

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